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ECONOMIC AND ENERGY EFFICIENCY OF CULTIVATION OF ALFALFA-CEREAL HERBAGE

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Aim. ***To establish indicators of economic and energy efficiency in the cultivation of alfalfa-cereal mixtures under the influence of lime and fertilizers.*** **Methods.** ***Field, laboratory, mathematical-statistical, economic-mathematical.*** **Results.** ***The influence of lime and fertilizers on only alfalfa, alfalfa-cereal and only cereal agrophytocenoses was carried out during 2019−2021 in the Forest-steppe zone of Ukraine on dark gray podsolized coarse silt-light loam soil. The results of research on the study of economic and energy efficiency indicators are shown in terms of the cost of gross production, total costs, net profit, profitability per 1 hectare, cost of fodder units and raw protein, payback of total energy costs, gross and exchangeable energy output are calculated per1 ton.*** **Conclusions.** ***The use of symbiotic nitrogen fixed by alfalfa in its single and mixture crops with cereal increases the net profit from 6.9 to 27.1−35.0 or by 20.2−28.1 thousand UAH/ha, profitability − from 114 to 300−343%, KEE − from 5.7 to 10.9−12.4 and BEC − from 3.0 to 6.1−7.1, and the cost of 1 ton of fodder units decreases from 2.6 to 1.2−1.4 thousand UAH, and energy consumption per 1 ton of fodder units from 4.30 to 1.64−2.0 MJ. The annual application of $P_{45}K_{90}$ reduces net profit by 3.7−4.4 thousand UAH/ha, profitability by 160−168%, KEE by 1.6−2.5 and BEC by 0.6−1.3 and increases the cost price of 1 ton of fodder units − by 763−827 UAH and energy costs per 1 ton of fodder units − by 0.58−1.55 compare that to the option without fertilizers. The application of lime reduces the profitability of cultivation by 25−78%, KEE – by 0.2−1.0 and BEC – by 0.1−0.5 and increases the cost of 1 ton of fodder units – by 143−369 UAH/ha. The combined application of the fertilizers and lime reduces profitability by 55-194%, KEE by 2.1−2.8 and BEC by 1.0−1.5, and increases cost and energy costs per 1 ton of fodder units.***

Key words: *gross and exchangeable energy, lime, fertilizers, alfalfa seeds, alfalfa-cereal mixtures, return on costs, profitability, symbiotic nitrogen, cost price, total costs, net profit.*

For the successful development of animal husbandry in Ukraine, it is absolutely necessary to master energy and resource-saving technologies in fodder production and cereal production, which are based on the use of the huge potential of perennial herbage, and particulary legumes as a major source of natural cheap symbiotic nitrogen. This helps to improve the economic and energy efficiency of swards fodder production on the basis to reduce the cost of milk and meat [1; 2].

Analysis of recent research and publications.

To summaries the results of scientific research and the experience of advanced farms on the economic efficiency shows that the cost price of pasture swards based fodder production is the cheapest. The cost of 1 ton of fodder units obtained from cultivated pastures is 1.9 times lower than that mown green mass of perennial swards, 2.5 times lower than that hay from natural pastures, 10.5 times lower than that fodder root crops, and 3.9 times lower than that of concentrated feeds [1−3]. The low cost of fodder from natural fodder lands, and most importantly from cultivated pastures primarily due to the fact that the funds for attracting perennial swards and organizing the land area are divided into several years, during which it is planned to use them in a relatively low cost of maintenance and use. Compared to to hay on pastures fields, there are no costs for mowing and transportation of green mass, which also reduces the costs of production of 1 ton of fodder units [3]. It should be noted that in recent years, with an increase in the cost of mineral, especially nitrogen fertilizers, the costs of producing pasture based fodder has increased. Therefore, in the conditions of the increase in mineral fertilizers, especially nitrogen fertilizers, an important factor in reducing the cost of fodder (by 1.2–1.5 times) is the use of legumes as a source of symbiotic nitrogen [4; 6].

It is known that pasture based fodder is a source of energy obtained both through photosynthesis and the total energy expenditure for their production. The effect of the conversion of the last type of energy into the energy of animal husbandry products is a criterion for evaluating the energy-saving balance. In the structure of energy consumption for the production of animal husbandry products, depending on its type, fodder accounts from 50 to 80%, so reducing energy consumption for their production is extremely important for reducing the cost of livestock products [7].

The life of any living organism is inextricably linked with the exchange and transformation of energy. Nutrients, in particular in the form of hydrocarbons, proteins, fats, etc., play a decisive role in the metabolism of substances and energy in the body of animals. The main task of the energy analysis of fodder production is to comply the basic principles that ensure the rational use of non-renewable (fuel and lubricants) and renewable (solar radiation) energy [7; 8].

In fodder production and cereal production, the energy evaluation of technologies is evaluated based on the payback of total energy costs, output from 1 ha of gross or exchangeable energy in GJ. In the first case, it is called the energy efficiency coefficient and the bioenergy coefficient, respectively. The coefficient of energy efficiency as the ratio of output from 1 ha of gross energy to total costs in the production of swards fodder on improved natural fodder lands ranges from 3 to 6, and the bioenergy coefficient is 1.5 to 3. An increase in the specified coefficients means an increase in the energy efficiency of feed biomass production [1; 2].

It should be noted that, like the cost of 1 ton of fodder units, energy costs for the production of sward fodder as a whole have increased, especially in recent years with an increase in energy resources and an increase in energy costs for mineral fertilizers and fuel. In the context of an increase in the cost mineral fertilizers, especially nitrogen fertilizers, an important factor in reducing energy costs for the production of sward fodder (by 1.4–1.8 times compared to cereal stands) is the use of legumes wards as a source of symbiotic nitrogen [4–6].

The goal of the work. To establish indicators of economic and energy efficiency when growing alfalfa-cereal mixtures on dark gray soils in comparison with alfalfa sowing and cereal grass stand on different backgrounds of fertilization and liming.

Research materials and methods. A study on the economic and energy efficiency of growing alfalfa-cereal mixtures (*Medicago sativa* L. + *Poaceae*) with various cereal s components under the influence of lime and fertilizers was carried out during 2019–2021 in the forest-steppe zone of Ukraine on dark gray podsolized coarse silt-light loam soil at the NSC «Institute of Agriculture of NAAS» (the village of Chabany, Kyiv region). The scheme of the experiment is shown in Table 1. The content of humus in the 0–20 cm layer is 2.4%; pH (saline) – 5.2; alkaline hydrolyzed nitrogen – 13.1, mobile phosphorus – 17.1, and potassium – 12.9 mg per 100 g of soil.

According to the experiment scheme, 1.5 t/ha of lime was applied once in the pre-sowing tillage during liming in the spring of 2019, and mineral fertilizers were applied annually: phosphorus and potash fertilizers – in the spring, nitrogen – in equal parts under each cutting. The use of swards is three slopes.

The sown area of the plot is 16 m^2, the registered area is 10 m^2 with four replications. Placement of plots is consistent. The technology of growing perennial swards with the exception of the investigated factors was generally accepted for the right-bank forest-steppe of Ukraine. During planting, regionalized varieties of perennial swards were used in the experiment, mainly selections of the NSC «Institute of Agriculture of NAAS».

Field studies were performed according to generally accepted methods in fodder production [9]. The economic assessment of the researched elements of the technology of growing alfalfa-cereal mixtures in comparison with pure stands of alfalfa and cereal was carried out according to the method of evaluating the effectiveness of scientific research using technological maps at prices that developed in 2021.

The evaluation of the energy efficiency of the studied elements of the technology of growing alfalfa-cereal mixtures was carried out according to the methods of O. K. Medvedovskyi and P. I. Ivanenko [10].

Results and their discussion. Our calculations of the economic efficiency of growing alfalfa, alfalfa-cereal and pure herbage on average for 2019–2021, depending on fertilization and liming are shown in Table 1. According to these data, the studied factors, in particular the type of pure swardsstand, fertilization and liming, significantly influenced economic efficiency indicators, in particular, on the value of gross production, which ranged from 13.0−54.9 thousand UAH/ha, total costs (6.1-24.7 thousand UAH/ha), net profit (–1957−37438 thousand UAH/ha, profitability (–12−343%) and the cost of 1 ton of fodder units (1343−6259 UAH). The cost of gross production was the highest on alfalfa-cereal mixtures with the combined application of $P_{45}K_{90}$ and 1.5 t/ha of lime at sowing, combined costs − on cereal es for the combined application of $N_{90}P_{45}K_{90}$ and lime.

The inclusion of alfalfa in alfalfa-cereal mixtures, as well as pure stand of alfalfa in comparison with a pure cereal stand, provided better indicators of the economic efficiency of growing pasture agrophytocenoses. In the average of three years of pasture use, against the background of no fertilizers and liming, the net profit increased from UAH 6.9 thousand up to 27.1−35.0 thousand or by 20.2−28.1 thousand UAH/ha, profitability increased from 114 to 300−243%, and the cost of 1 ton of fodder unit decreased from 2.6 thousand to 1.2−1.4 thousand UAH/ha. The application of $P_{45}K_{90}$ significantly worsened the indicators of economic efficiency in all traded swards and combinations both in limed and unlimed plots. For example, treatment of pure alfalfa stand and alfalfa-cereal mixtures grown without liming with the introduction of $P_{45}K_{90}$ comparetothe plots without fertilizers, the net profit decreased by 3.7–4.4 thousand UAH/ha, the profitability decreased by 160−168%, and the cost price 1 ton of fodder unit increased by 763−827 UAH/ha.

The application of lime for the cultivation of pure alfalfa stand and alfalfa-cereal mixtures did not affect or slightly increased (at most by 2.8 thousand UAH/ha) the net profit. However, the profitability of cultivation in this case decreased by 25−78% and the cost of 1 ton of feed units increased by 143−369 UAH/ha. On a pure cereal stands, lime application worsened all indicators of economic efficiency.

The cost of gross production increased in all investigated pure cereal stands with the combined application of $P_{45}K_{90}$ and lime but the total costs increased sharply (by 10.0−11.2 thousand UAH/ha). As a result, the net profit decreased by 1.5−8.9 UAH/ha compared that to the plots without fertilizers. The decrease was smaller by 4-5 thousand UAHha^{-1}on pure alfalfa stand and alfalfa-cereal mixtures compare to pure cereal stands, where the net profit had a negative value (-2.0 thousand UAH/ha). However, profitability case decreased and the cost of 1 ton of fodder units and raw protein increased to a greater extent than the net profit. Profitability decreased by 2.0−2.3 times on pure alfalfa stand and alfalfa-cereal mixtures by reaching a negative value on pure cereal stands. The cost of 1 ton of fodder units and raw protein on pure alfalfa stand and alfalfa-cereal stands increased by 1.7−1.9 times, while on cereal stands – by 2.3−2.5 times.

The application of N_{90} on pure cereal stands in creases the cost of gross production by 1.7-1.8 times, and costs by 1.5−2.4 times. At the same time, the net profit increased by 1.5−3.1 thousand UAH/ha and profitability − by 11−54%, and the cost of 1 ton of fodder units changed little and irregularly.

The analysis of our data on the energy efficiency of the formation of different types of pastures, namely, alfalfa-cereal mixtures and pure stands of alfalfa and cereal on average for 2019−2021 under different fertilization systems with liming and unliming showed that the total energy consumption ranged from 10.2−22.4 GJ·ha^{-1} (Table 2). The highest total energy consumption was on the cereal s herbage with the combined application of $N_{90}P_{45}K_{90}$ and lime on the plots. In the second city in terms of costs, the treatments of all pure cereal stands with combined application of $P_{45}K_{90}$ and lime on was the highest total energy consumption. Against this background, the total energy consumption amounted to 19.7−20.0 GJ·ha, which is 1.8−2. 0 times more compared to the treat ments without fertilizer application. The lowest total energy consumption (10.2 GJ·ha) was on pure cereal stands without fertilizer application, which is 3. 0−3.3 GJ/ha less than on pure alfalfa stand and alfalfa-cereal mixture. The total energy consumption increased by 5.8−7.5 GJ·ha by applying N_{90} to the pure cereal stands.

Also, similar models were found for energy consumption per 1 ton of feed units, which were obtained for total energy consumption,. However, according to this indicator, the highest costs (6.43 MJ·ha) were on pure cereal stands with the combined application of $P_{45}K_{90}$ and lime. The energy consumption per 1 ton of fodder units decreased by 3.86−4.43 MJ on the agro background with pure alfalfa stand and alfalfa-cereal mixtures. The lowest version of fodder unit parameters was obtained in the treatments without fertilizers 1.64, 2. 00 and 4.30 MJ·ha^{-1} on pure alfalfa stand, alfalfa-cereal mixture, and pure cereal stands, respectively.

Comparing the fertilized plots with $P_{45}K_{90}$to unfertilized the energy consumption per 1 ton of fodder

Table 1. Economic efficiency of growing alfalfa-cereal mixtures, pure alfalfa and cereal stands depending on fertilization and liming in average, 2019–2021

Cereal land (types and combinations of swads and seed sowing rate,·ha^{-1}kg)	Liming*	Fertilizers	Gross producion, UAH/ha	Costs, UAH/ha	Net profit, UAH/ha	Profita-bility, %	Cost of 1 ton, UAH	
							unit fodder	raw protein
1	2	3	4	5	6	7	8	9
Alfalfa, 18	–	–	45210	10195	35015	343	1240	6255
		$P_{45}K_{90}$	48290	17587	30703	175	2003	9993
	+	–	51480	13993	37487	268	1495	7774
		$P_{45}K_{90}$	54945	21434	33511	156	2146	10992
Alfalfa, 10 + cock's-foot, 10	–	–	36135	9040	27095	300	1376	6746
		$P_{45}K_{90}$	38720	16369	22351	137	2325	11135
	+	–	40700	12621	28079	222	1706	8528
		$P_{45}K_{90}$	41745	19754	21991	111	2603	12663
Alfalfa, 10 + smooth brome, 15	–	–	41415	9712	31703	326	1290	6607
		$P_{45}K_{90}$	45155	17188	27967	163	2094	10743
	+	–	40700	12621	28079	222	1706	7888
		$P_{45}K_{90}$	47245	20454	26791	131	2381	11688
Alfalfa, 10 + meadow fescue, 12	–	–	38555	9348	29207	312	1334	6537
		$P_{45}K_{90}$	40260	16565	23695	143	2263	10970
	+	–	42130	12803	29327	229	1671	8260
		$P_{45}K_{90}$	44165	20062	24103	120	2498	12159
Alfalfa, 10 + tall fescue, 14	–	–	43230	9943	33285	335	1265	6673
		$P_{45}K_{90}$	43505	16978	26527	156	2146	10678
	+	–	45760	13265	32495	245	1594	8088
		$P_{45}K_{90}$	47355	20468	26887	131	2377	11696
Alfalfa, 10 + perennial rye cereal, 14	–	–	38005	9278	28727	310	1343	6723
		$P_{45}K_{90}$	41360	16705	24655	148	2221	11601
	+	–	40425	12586	27839	221	1712	8447
		$P_{45}K_{90}$	46475	20356	26115	128	2409	13133
Alfalfa, 10 + timothy, 8	–	–	41085	9670	31415	325	1295	5969
		$P_{45}K_{90}$	44605	17118	27487	161	2111	9895
	+	–	45815	13272	32543	245	1593	7456
		$P_{45}K_{90}$	48565	20622	27943	136	2335	10854
Alfalfa, 10 + wheat cereal , 14	–	–	42350	9831	32519	331	1277	6031
		$P_{45}K_{90}$	45430	17223	28207	164	2085	9898
	+	–	46695	13384	33315	249	1576	7436
		$P_{45}K_{90}$	51755	21028	30727	146	2235	11063
Alfalfa, 10 + smooth brome, 8 + tall fescue, 6	–	–	42955	9908	33047	334	1269	6311
		$P_{45}K_{90}$	43450	16971	26479	156	2148	10476
	+	–	45870	13259	32611	246	1590	8036
		$P_{45}K_{90}$	49005	20678	28327	137	2320	11682
Smooth brome, 15 + tall fescue, 14	–	–	13035	6100	6935	114	2574	17428
		$P_{45}K_{90}$	13640	13177	463	4	5313	33787
	+	–	13540	9177	4363	48	3700	24150
		$P_{45}K_{90}$	14190	16147	–1957	–12	6259	40368
Smooth brome, 15 + tall fescue, 14	–	N_{90}	22770	14339	8431	60	3464	18622
		$N_{90}P_{45}K_{90}$	24915	21612	3303	15	4771	26681
	+	N_{90}	23705	17458	6247	36	4051	22099
		$N_{90}P_{45}K_{90}$	25905	24738	1167	5	5252	29104

*(–) – without limingand fertilizers; (+) - introduction of lime.

Table 2. Energy efficiency of growing alfalfa-cereal mixtures, pure alfalfa and cereal stands in average, 2019–2021

Cereal land (types and combinations of cereal es swads and seed sowing rate, kg·ha⁻¹)	Liming*	Fertilizers	Costs energy, GJ·ha⁻¹	KEE	BEK	Energy consumption per 1 ton fodder unit, MJ
1	2	3	4	5	6	7
Alfalfa, 18	–	–	13.5	12.4	7.1	1.64
		$P_{45}K_{90}$	17.7	9.9	5.8	2. 02
	+	–	15.6	11.4	6.8	1.67
		$P_{45}K_{90}$	20.0	9.6	5.7	2. 00
Alfalfa, 10 + cock's-foot, 10	–	–	13.2	10.9	6.1	2. 00
		$P_{45}K_{90}$	17.3	9. 0	4.9	2.46
	+	–	15.2	10.4	5.6	2,05
		$P_{45}K_{90}$	19.5	8.5	4.7	2.57
Alfalfa, 10 + smooth brome, 15	–	–	13.5	11.9	6.7	1.79
		$P_{45}K_{90}$	17.6	9.6	5.5	2.14
	+	–	15.3	11.3	6.4	2. 07
		$P_{45}K_{90}$	19.7	9.2	5.2	2.29
Alfalfa, 10 + meadow fescue, 12	–	–	13.3	11.2	6.3	1.90
		$P_{45}K_{90}$	17.2	9. 0	5.1	2.35
	+	–	15.3	10.5	6. 0	2. 00
		$P_{45}K_{90}$	19.7	8.6	4.9	2.45
Alfalfa, 10 + tall fescue, 14	–	–	13.2	12. 0	6.9	1.68
		$P_{45}K_{90}$	17.5	9.6	5.4	2.21
	+	–	15.3	11.2	6.4	1.84
		$P_{45}K_{90}$	19.8	9.1	5.2	2.30
Alfalfa, 10 + perennial rye cereal, 14	–	–	13.2	10,9	6.3	1.91
		$P_{45}K_{90}$	17.2	8,8	5.1	2.29
	+	–	15.1	10.0	5.8	2. 05
		$P_{45}K_{90}$	19.5	8.3	4.9	2.31
Alfalfa, 10 + timothy, 8	–	–	13.5	11.8	6.7	1.81
		$P_{45}K_{90}$	17,.5	9.7	5.5	2.16
	+	–	15.4	11.3	6.5	1.85
		$P_{45}K_{90}$	19.9	9.2	5.3	2.25
Alfalfa, 10 + wheat cereal , 14	–	–	13.5	12. 0	6.8	1.75
		$P_{45}K_{90}$	17.5	9.8	5.6	2.12
	+	–	15.5	11.4	6.5	1.83
		$P_{45}K_{90}$	19.8	9.4	5.5	2.10
Alfalfa, 10 + smooth brome, 8 + tall fescue, 6	–	–	13.6	12.4	7. 0	1.74
		$P_{45}K_{90}$	17.7	9.6	5.4	2.24
	+	–	15.5	11.4	6.4	1.86
		$P_{45}K_{90}$	19.8	9.4	5.4	2.22
Smooth brome, 15 + tall fescue, 14	–	–	10.2	5.7	3. 0	4.30
		$P_{45}K_{90}$	14.5	4.1	2.2	5.85
	+	–	12.3	4.8	2.6	4.96
		$P_{45}K_{90}$	16.6	3.6	2. 0	6.43
Smooth brome, 15 + tall fescue, 14	–	N_{90}	17.7	5.4	2.9	4.28
		$N_{90}P_{45}K_{90}$	22. 0	4.6	2.5	4,86
	+	N_{90}	20.0	4.9	2.7	4.64
		$N_{90}P_{45}K_{90}$	22.4	4.7	2.6	4.59

Note. KEE and BEC are the payback of total energy costs with output from 1 ha, respectively, of gross and exchangeable energy.

units on pure alfalfa stand and alfalfa-cereal stands increased by 0.32–0.46 MJ, and on pure cereal stands – by 0.58–1.55 MJ., The energy consumption per 1 ton of fodder units increased by 0.36–0.57 MJ with the combined application of $P_{45}K_{90}$ and lime on pure alfalfa stand and alfalfa-cereal mixtures, and on pure cereal stands – by 2.13 MJ. The energy consumption of fooder units per 1 ton decreased by applying N_{90} up to 0.02–1.84 MJ.

The energy consumption of fodder units per 1 ton ranged from 1.64 to 2.46 MJon pure alfalfa stand and alfalfa-cereal mixture, which is 2.66 to 4.43 less than on pure cereal stands.

The energy efficiency coefficient (EEE) and bioenergy coefficient (BEC), which represent the payback of the total energy input from 1 ha of gross and exchangeable energy, respectively, significantly differed between the tested cereal and fertilization and liming options.

According to our data, on average, the CEE ranged from 7.3 to 15.2, and the BEC ranged from 2.0 to 7.1 over three years. The higher values of the parameters was obtained on pure alfalfa stand and alfalfa-cereal stands KEE by 8.3–12.4 and BEC 4.9–7.1, which are 1.5–3.0 times more than on cereal stands, respectively.

The largest values were determined in the version without fertilizers and liming, the parameters KEE of 10.9–12.4 and BEC – 6.1–7.1 were found on pure alfalfa stand and alfalfa-cereal stands and, 5.7 and 3. 0 on pure cereal stands, respectively. The parameters of KEE decreased by 1.8–2.5, and BEC – by 1.1–1.3 after the application of $P_{45}K_{90}$ was done on pure alfalfa stand and alfalfa-cereal mixture, and pure cereal stands – by 1.6 and 0.6–0.8, respectively. With the application of lime, KEE decreased by 0.3–1.0, and BEC by 0.1–0.5, and by 0.5 and 0.9, respectively, in pure cereal stands. The combined application of $P_{45}K_{90}$ and lime the coefficients decreased by 2.4–2.8 and 1.4-1.5 on pure alfalfa stands and alfalfa-cereal mixture, respectively, and by 2.1 and 1.0 on pure cereal stands. The additional application of nitrogen fertilizers in the dose of N_{90} on pure cereal stands both parameters KEE and BEC slightly changed and fluctuated within the range of 3.6–4.9 and 2.0–2.9, respectively. However, the application of N_{90} shows a tendency to increase, the parameters KEE and BEC by 0.3 and 0.1, respectively. But fertilization combined with $P_{45}K_{90}$ or lime significantly decrease the values, especially in combination with the application of $P_{45}K_{90}$ and lime.

Conclusions

1. Due to the use of symbiotic alfalfa nitrogen in its pure stand and mixtures with cereals, the net profit increases from 6.9 thousand to 27.1–35.0 h or by 20.2–28.1 thousand UAHha^{-1}in an average of three years of cereal land life. The profitability decreased from 114 to 300-343%, KEE – from 5.7 to 10.9–12.4 and BEC – from 3.0 to 6.1–7.1, and the cost of 1 ton of fodder units from 2.6 to 1.2–1.4 thousand UAH/ha, and energy consumption per 1 ton of fodder units from 4.30 to 1.64–2. 0 MJ.
2. Annual application of $P_{45}K_{90}$ compared to the option without fertilizers reduces net profit by 3.7–4.4 thousand UAH/ha, profitability – by 160–168%, KEE – by 1.6–2.5 and BEC – by 0.6–1.3 and increases the cost of 1 ton of fodder units by 763–827 UAH and energy costs per 1 ton of fodder units by 0.58–1.55. The application lime on the swards reduces the profitability of cultivation by 25–78%, KEE – by 0.2–1.0 and BEC – by 0.1–0.5 and increases the cost of 1 ton of fodder units – by 143–369 UAH/ha. The combined application of the fertilizers and lime reduces profitability by 55–194%, KEE by 2.1–2.8 and BEC by 1.0–1.5, and increases cost and energy costs per 1 ton of fodder units.
3. Application of nitrogen fertilizers in a dose of $N_{90\ (30\ +\ 30\ +\ 30)}$ on pure cereal stands increases the net profit by 8.2–8.4 thousand UAH/ha, as well as profitability and reduces the cost of 1 ton of fodder unit and raw protein, and in most cases improves energy efficiency.

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Кургак В.Г., Сарунайте Л., Штакал В.М., Гавриш Я.В.

Економічна та енергетична ефективність вирощування люцерно-злакових травостоїв

Мета. *Встановити показники економічної та енергетичної ефективності при вирощуванні люцерно-злакових сумішей під дією вапна та добрив.* **Методи.** *Польовий, лабораторний, математико-статистичний, економіко-математичний.* **Результати.** *Показано результати досліджень з вивчення показників економічної та енергетичної ефективності в розрахунку на 1 га за вартістю валової продукції, сукупними витратами, чистим прибутком, рентабельністю, собівартістю 1 т кормових одиниць і сирого протеїну, окупністю сукупних витрат енергії виходом валової і обмінної енергії при вирощуванні люцернового, люцерно-злакових і злакового агрофітоценозів під дією вапна та добрив, які нами проведено впродовж*

2019–2021 рр. у зоні Лісостепу України на темно-сірому опідзоленому крупнопилувато-легкосуглинковому ґрунті. **Висновки.** *Завдяки використанню симбіотичного азоту люцерни посівної одновидовому її посіві та сумішах із злаками в середньому за три роки життя чистий прибуток збільшується від 6,9 тис. грн до 27,1–35,0, або на 20,2–28,1 тис. грн/га, рентабельність – від 114 до 300–343%, КЕЕ – від 5,7 до 10,9–12,4 і БЕК – від 3,0 до 6,1–7,1 та зменшується собівартість 1 т кормових одиниць від 2,6 до 1,2–1,4 тис. грн і затрати енергії на 1 т кормових одиниць від 4,30 до 1,64-2,0 МДж. Щорічне внесення $P_{45}K_{90}$ порівняно з варіантом без добрив зменшує чистий прибуток на 3,7–4,4 тис. грн/га, рентабельність – на 160–168%, КЕЕ – на 1,6–2,5 і БЕК – на 0,6–1,3 та збільшує собівартість 1 т кормових одиниць – на 763–827 грн і затрати енергії на 1 т кормових одиниць – на 0,58–1,55. Внесення вапна зменшує рентабельність вирощування на 25–78%, КЕЕ – на 0,2–1,0 і БЕК – на 0,1–0,5 та збільшує собівартість 1 т кормових одиниць – на 143–369 грн/га. Поєднане внесення зазначених добрив і вапна зменшує рентабельність на 55–194%, КЕЕ – на 2,1–2,8 і БЕК – на 1,0–1,5 та збільшує затрати коштів та енергії на 1 т кормових одиниць.*

Ключові слова: *валова і обмінна енергія, вапно, добрива,люцерна посівна, люцерно-злакові суміші, окупність витрат, рентабельність, симбіотичний азот, собівартість, сукупні витрати, чистий прибуток.*

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